IFC of BIM Automatic Retrieving and Linking for Building Envelope Energy Efficiency Measuring - Ministry of The Interior Green Building Electronic Evaluation System in Taiwan

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Abstract

Taiwan Green Building System was established in 1999 by the Government. The main axis was ecological, energy saving, waste reduction and health (EEWH). To enhance the effectiveness of promoting green building design in Taiwan. The Green Building Measure System (GBM) was completed by the Ministry of the Interior, Taiwan. If the GBM and Building Information Modeling (BIM) can be linking and automatic retrieving, it will be able to enhance Taiwan's green building design more effective.

The results of this study are converting Industry Foundation Classes(IFC) and explored the projects that can be automated linking. The program of automated link was build, and evaluated it proficiency. Building the GBM of BIM modeling guidelines, and completed a BIM digital building model. It provides EEWH more automatic to improve calculation of Green Building in Design.

Keywords –

IFC; BIM; EEWH; GBM; green building

1 Introduction

Induction the GBM for direct linking, program handling and manual identification to explore different automated solutions.

The issue of sustainable development is the national research projects around the world. And the sustainability is an abstract concept, it needs an evaluation tool to convert into quantized values. EEWH is one of the evaluation tools. British BREEAM, established in 1990, was the first green building evaluation tool of the world[1][2]. LEED was established by United States in 1996[3][4] . Taiwan's "Green Building Assessment System" was established in 1999 by the Government, and it has become an important part of sustainable national policy. Taiwan Green Building Assessment System is based on Ecology, Energy Saving, Waste Reduction and Health[5][6]. EEWH consists of five categories that includes Basic type, Community, Factory, Old Building Improvement, Accommodation. There are characteristics of Scientific quantification, design priority, parity technology, simple operation. The green building policy was greatly advanced, because it was supported by government[6] . Eastman et all brought up the concept of architectural description system basing on the proper classification of engineering data. Then, the issues and research was gradually being attention and discussion [7] . BIM technology was developed by industry and academia of Taiwan in 2002. It was used in the design,

construction, collaboration, operation and engineering stages.

To enhance the effectiveness of Taiwan green building assessment system and green building designing. Construction and Planning Agency Ministry of the Interior amend the Green building standard of building technical rules and design technical rules since 2012. The GBM was completed by planning, review and testing. It simplifies the green building design calculation process and time. And it just fills in the basic data and necessary calculation data, qualifying or not will be appeared immediately. GBM can correctly calculate and effectively examination the green building implementation effectiveness. Information integration and communication advantages make BIM technology development and application increase popularity in engineering with the promotion of BIM (Building Information Modelling). It gradually replaces the complex project management and integration of the work, reduce manpower resources, and improve work efficiency. BIM can be extended to design stage, proposing the better building project and energy saving with the development of visual simulation software for building physical environment analysis[8][9]. How to effectively apply BIM to do information management and building effectiveness assessment of building life cycle, improvement construction efficiency and providing solutions to reduce building energy consumption is the motivation for this study.

Building information modeling can effectively integrate the data and information of building, and build information that can be used internal access to the project. Therefore, this study will link the GBM and BIM. So that the GBM can obtain calculation data from BIM. It can enhance the effectiveness of the Green Building Assessment System and Green Building designing in Taiwan. Therefore, following is the research project: First, study the materials report of the BIM, including the number, material, nature, district, floor, type; second, GBM look-up table assessment, including EEWH specification project and component analysis; third, BIM data extraction, how to fill object data into the report data, and how to identify and output the composite component data; fourth, link the GBM and BIM.

2 Review

2.1 EEWH

From the substantive level of the definition of green building in Taiwan is using the least earth resources, manufacturing the least waste of the building, and from the positive level is based on human health and comfort, pursuit global environmental symbiosis and the Sustainable Development of Human Life Environment, accomplish ecology, Energy saving, waste reduction, healthy building [6]. The EEWH is not just about planting trees and greenery, it's about the comprehensive and the systematic of the living environment and emphasis on architectural environment design concept of the symbiosis with the global environment.

Taiwan green building evaluation system is mainly about ecology, energy saving, waste reduction, health, and particularly, scientific quantification, design priority, parity technology, simple operation. The grading method of the EEWH is Integrated, designer can choose from affordable technology to accomplish green building construction, not only to ensure maximum design flexibility and freedom of technology, but also prevent over equip and over invest. Taiwan green building evaluation system is divided into five parts, respectively, Green Building Evaluation Manual- Basic Version, Green Building Evaluation Manual for Eco-Community, Green Building Evaluation Manual for factory, Green Building Evaluation Manual for Building Renovation, Green Building Evaluation Manual for Residential Building. THE grading evaluation system in EEWH can be separated into five percentage sector, 95% Diamond,

80%~95% Gold, 60%~80% silver, 30%~60% bronze, under 30% is certified[6].

2.2 BIM

Computer assisted design is developed from computer assisted drawing towards BIM, reducing information delivery errors, and promote cooperation in building-related industries. In 2008, BIM is introduced by Eastman, he thinks that BIM is digitalized Architecture Design, Construction and Facilities management, to achieve communication and interworking. According to United States National Building Information Modeling Standard, there are four levels to elaborate BIM: BIM is a physically facility and functional characteristics expressed in a digitized manner; share information related to this facility; provide a reliable basis for all responses throughout the life cycle of the facility; Embed, extract, update modify information, Embed, extract, update and modify information can be supported and responded to their respective responsibilities in different stages of the construction.

BIM model trough tree dimensional, Immediate, dynamic, parametric programs, to increase the capacity of building design and construction [10][11][12]. In the process of creating the building information model, the information includes geometric, spatial relevance, geographic information, quantity and attribute data of buildings. With the help of the Building Information Model tool can strengthen the planning and management of construction programs[13].

With the development of visual simulation software for building physical environment analysis, BIM can extend from design stage to evaluation stage, and propose a better solution with energy efficiency goals[14][15]. Green BIM is based on three dimensional BIM, using combination of information and dynamic image system, and analyse architecture efficiency and program correction to achieve the best energy-saving goals[16][17]. Green BIM's important elements includes LEED、Material Data、CFD、GIS、Lighting / Daylighting、Energy、Structure、MEP, these elements affect each other and integrate with BIM Model, to understand how these elements affect designs like structure, mechanics, energy consumption, Lighting and other factors. For instance, daylight analysis can decide building position and forms, the openings may affect mechanical facility and alternative energy assessment. In response to design goals or assessment needs, users can build their own model application strategy.

The current BIM building energy analysis is based on the United States LEED, but due to the climate, regulations and other factors, it will be inaccurate to use it on Taiwanese architecture envelope energy measurement. If using Ministry of Interior Green building electronic assessment system and combination of BIM, it will enhance the effectiveness of the Green Building Assessment System and Green Building in Taiwan.

2.3 IFC

IFC is a standard building information exchange file format, provides the industries to share or exchange information between software, an IFC information file represents a project module, which contains building life cycle planning, design, construction, management and maintain information that is shared at all stages, including basic units, construction sites, buildings, building floors and related building elements, through information sharing and exchange, it creates an object-oriented database [18][19]. IFC describes the information by Express language, by using object-oriented technology for open information, the software company can exchange building information standard file format through IFC, and develop its application tools, furthermore, Providing research on the relevant units in the construction industry and develop through the element form for BIM validation, this step is important for checking

the drawing information, in the drawing stage, it will inevitably be some missing code, height setting error or component setting error, by setting parameter of the form function check(表單功能檢核), and the drawing is thoroughly check if an error is occurred or missing, when the model data is found to be problematic, Then return to the software to do the amendment.

3 Method

3.1 GBM

Green Building Measure System is built by Excel, which is a computer assisted software for EEWH. It includes full chapter 17 in Building Technical Regulations[20] . The following introduction will be function, assessment process, and operation. EEWH provides related information, print full evaluation table, customize code to manage building materials data. It can improve work efficiency.

As following Envelope energy saving step. First, fill in envelope calculation table. Second, build a basic database. Third, import Uar (average thermal transmittance) evaluation calculation table, choose decree application date, enter the number of data-roof and the description of building. Forth, build HWs (solar heat gain rate) and Gri (reflection rate of visible light) calculation table. Fifth, enter Aeq (equivalent transparency area), choose the position, floor and factor ki. Sixth, enter position, the description of façade, the position of roof and length to calculate factor Aen. Seventh, the system automatically calculates factor Req and check reference value.

3.2 Modeling

This study use ArchiCAD to build 3D model, research case is a house in Taipei, the building area is 166.63m2. First, sort out the plans (Figure 1). Before building the 3D model, sorting out AutoCAD layers and import to ArchiCAD. As following building model process. First, set the height of floors. Second, import AutoCAD file. Third, create column, then modify the type and scales… etc. Forth, create wall, then modify the type and scales… etc. Fifth, create door and window, then modify the type and scales… etc. Sixth, create floor slab, then modify the type, scales and floor number… etc. Seventh, create stair, then modify the type, scales and floor number… etc.

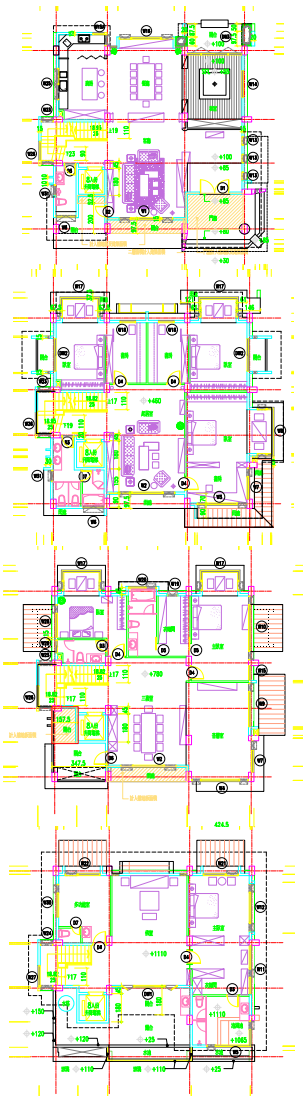


Figure 1 The plan of AutoCAD (from top to bottom:1F, 2F, 3F, 4F)

3.3 IFC2x3

IFC is an object-oriented technology for the basis of 3d graphic information, and the IFC2x3 is the most widely used version of the exchange

format[21][22][23] . There are three types of format in IFC database format, respectively, IFC-SPF、IFC-XML and IFC-ZIP, the IFC-XML format is based on XML format, the format can take advantage of XML tools to operate model exchange and analyze, but there must be many definitions of tag in XML format in order to analyze, therefore, not many user using IFC-XML due to the large file. The IFC-SPF file format is pure text file, usually each string of text contains an object definition, since the data is stored with pure text, it has advantage of small file, so it is widely used IFC file format. Finally, IFC-ZIP is based on IFC-SPF compressed ZIP file.

4 Experiment & Results

4.1 GBM

This study is based on Envelope Energy-Saving amid Daily Energy Saving Index on evaluation of Envelope Energy saving includes roof average thermal transmittance (Uaw), solar heat gain rate (HWs), reflection rate of visible light, equivalent transparency area (Aeq), Req calculation and Evaluation of baseline values. The results of the calculation will be used as a basis for later corrections. The results of the calculation are as follows (Table 1). 1.The system will calculate the average thermal transmittance after roof construction details table - up. The design value for this example is 0.712, which is less than the reference value of 0.8. 2.The skylight has an angle of 100 degrees greater than 80 degrees. When the skylight elevation is greater than 80 degrees or Hwa is less than 1.0m2 will not be assessed. So, the study case HWs need not be evaluated. 3.This study case uses double glass. Gri value of 0.15, less than the reference value of 0.25. It is in line with regulations. 4.Wall average thermal transmittance table value of 2.144, less than the standard value of 3.5. It is in line with regulations. 5.Aeq assessment items must review the window type, Window area, orientation, floor and shade form. It needs to pay attention to shade forms such as: horizontal, vertical, grid, unilateral vertical and permanent -style shading types. And Calculate the outer shading coefficient. The Aeq of this study case is 303.33m2. 6.Req calculations and benchmarks to review Req = Aeq / Aen.

Table 1 The project of energy saving assessment

evaluation items	standard value	Design value	compliance audit or not
average thermal transmittance	0.8	0.712	O
HWs (solar heat gain rate)	-	Free assassment	X
Gri (reflection rate of visible light)	0.25	0.15	O
Average heat transfer rate of walls	3.5	2.144	O
Aeq (equivalent transparency area)	-	303.33m^2	-
Req (Calculation and normal value review)	13%	33.55%	X

4.2 BIM Model

The research case of this study is a house in Taipei, plans shown below Figure 2. The case model is LOD300, which includes wall, door, window, floor slab, column and beam. Pay particular attention on wall and window during the modeling process to connect with GBM data efficiently. According to the unit of GBM, set up the element unit to meter, it makes data modifying much more uncomplicated.

4.3 Linking function

Component, quantity and spatial table. The major review of envelope energy saving is

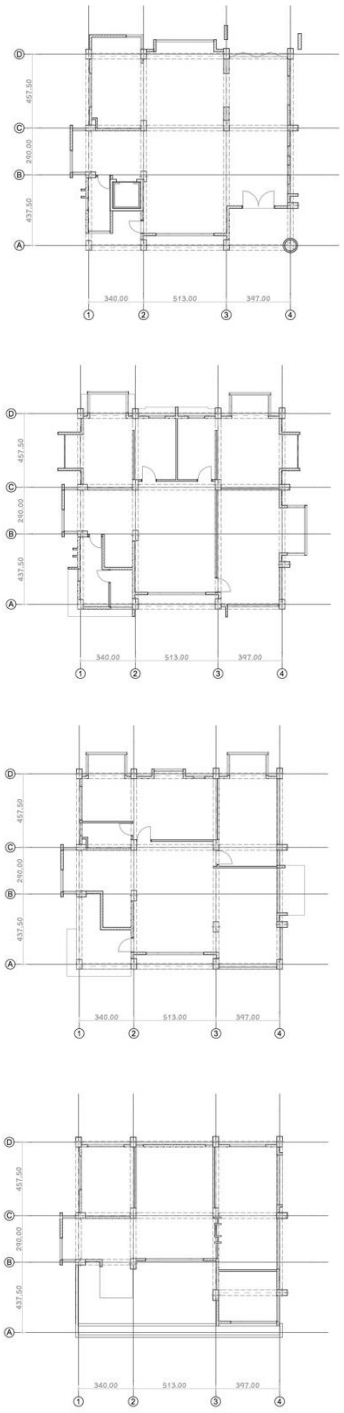


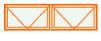
Figure 2 3D model plan of BIM (from top to bottom:1F, 2F, 3F, 4F)

Equivalent transparency area (透光部位等價開窗面積), shade form(遮陽形式), in terms of the output, the report is based on walls and windows. The external wall component report is shown in Table 2, wall area calculates the requirement of Aen, but the wall must be picked out. Table 3 lists the window elements, width and height calculates the requirement of Aeq, but the report data unit shows centimeter, while GBM requires meters, so the unit conversion is required.

Table 2 Wall element (part)

Wall type	Volume [m^3]	Thickness [m]	Height [m]	Area [m^2]	Perimeter [m]
Plywood	0.87	35	345	0.29	2.35
Plywood	0.95	35	345	0.32	2.5
Concrete	0.05	15	25	0.22	3.64
Concrete	0.04	15	130	0.58	8.4
Concrete	0.15	15	130	0.28	4.1
Concrete	0.15	15	130	0.31	4.4
Concrete	0.95	15	25	3.82	51.64
Concrete	0.66	15	120	0.55	7.6
⋮					

Table 3 Window element (part)

Opening Name	2-Sash Sliding Window 19	Double Window 19	Glass Block Wall 19
Quantity	1	1	2
W x H Size	80.00x60.00	210.00x60.00	45.00x240.00
Sill height	180	90	0
Head height	240	150	240
2D Symbol			
View from Side Opposite to Opening Side			

among seven projects that needs to be evaluated on envelope energy saving, only Equivalent transparency area Aeq and envelope area can be linked via excel. When calculating the link in Aeq, due to the difference of the report data unit between Archicad and GBM, therefore the report data unit of the window element has to be converted to meters, the outer shading coefficient still needs to fill in the calculation. While Aen calculates the link, the external wall must be picked out, then sum up the area, and the Aen can be found.

4.4 GBM link BIM

As mentioned above, there are currently only two items that can be linked directly to excel on the seven projects of envelope energy saving. And GBM and BIM linking is also the two main projects. Other parts need to manually identify the plan, it will be discussed at the next stage of the study. The steps for linking GBM to BIM are as follows: First, the BIM model is output in IFC format and open with excel (Figure 3); Second, using excel formula to retrieving the information, such as the height and width of the window (Figure 4). Finally, link the retrieving data to GBM excel.

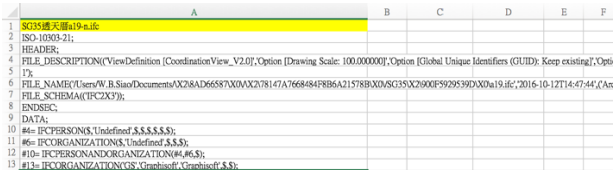


Figure 3 IFC format open with excel.

Figure 4 Retrieving the information with excel link to GBM.

5 Conclusion

There are 7 item need to calculation for Building envelope energy efficiency measuring of EEWH. Using GBM to calculation these items can save a lot of time. There are a lot of options and values to choosing in GBM, and it can simplify the calculation process.

In the process of linking GBM and BIM, only Aeq and Aen can be linked. Points for attention, GBM's units is meter. It should be unified in the settings of the report output. When Aen linking, the external components must be selected out, and then summing the area.

It is feasible to link GBM and BIM, but the degree of connection is not as expected. The future will be a graphical identification of the study, so that the system can be identified through the graphics and select the calculated value. Expect to increase the degree of link.

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